N-63-4-3

TM-(L)-714/012/00

CATALOGED BY DDC
AS AD No. 410188

410188

TECHNICAL MEMORANDUM

(TM Series)

DDC AVAILABILITY NOTICE

Qualified requesters may obtain copies of this report from DDC.

This document was produced by SDC in performance of contract AF 19(628)-1648, Space Systems Division Program, for Space Systems Division, AFSC.

General Purpose
Satellite Computer Program Descriptions
Milestone 11
Time Check (TCK)

by
C. M. Chiodini

14 November 1962

Approved
B. G. Ciaccia

SYSTEM DEVELOPMENT CORPORATION
2500 COLORADO AVE.
SANTA MONICA
CALIFORNIA

DDC
RECEIVED
JUL 26 1963
TISIA B

The views, conclusions or recommendations expressed in this document do not necessarily reflect the official views or policies of agencies of the United States Government.

Permission to quote from this document or to reproduce it, wholly or in part, should be obtained in advance from the System Development Corporation.

Although this document contains no classified information it has not been cleared for open publication by the Department of Defense. Open publication, wholly or in part, is prohibited without the prior approval of the System Development Corporation.

SUBROUTINE IDENTIFICATION

A. Title: TCK, Time Check, Identification G31, Mod. 01.

B. Programmed: C. Murray, 13 July 1961, Lockheed Missiles and Space Division.

C. Documented: C. M. Chiodini, 11 October 1962, System Development Corporation.

PURPOSE

TCK deletes Tracking Data Points from the Constant Pool of the user function when the component times (T) are out of range or out of order.

USAGE

A. Calling Sequence.

```
L       SLJ   4   TCK
L+1     NOP       T
        NOP       AZ
L+2     NOP       EL
        NOP       SR
L+3     Normal return
```

where:

T, AZ, EL, and SR are the beginning addresses of the tracking point components in the Constant Pool of the user function.

B. Input Parameters.

1. A Register: LIST TEST value. A zero value will result in an off-line listing of the deleted times modulo 86400 seconds. Any non-zero value in LIST TEST will bypass the output.
2. Q Register: The pass duration in floating point seconds if UHF Data (Format=3) is to be processed.
3. NT: The number of tracking data points. This integer item is in the Reference Pool.
4. FORMAT: The type of radar. This integer item is in the Reference Pool.

ITEM VALUE	DATA TYPE
0	Mod 2
1	Doppler (Range-Rate)
2	TLM18
3	UHF

5. Tracking data points in the Constant Pool of the user function.

SYMBOL	DEFINITION	FORMAT	UNITS
T	Machine Time	Floating Point	Seconds
AZ	Azimuth	Floating Point	Radians
EL	Elevation/Range	Floating Point	Radians
SR	Slant Range Rate	Floating Point	Feet

C. Output.

1. The number of valid tracking data points, NT in the Reference Pool.
2. A set of revised points in the Constant Pool of the user function with bad points deleted.
3. An off-line listing (on Tape 3) of component Times in the tracking data array which were out of range or out of order. This output is optional, dependent upon the LIST TEST value.
4. User Functions.

ASCENT	DATLAP
CCOORD	NBURN
COMPARE	REDUCE
REENTRY	

METHOD

TCK is subdivided into 4 major program regions and an internal output subroutine. In the first region, TCK obtains input parameters from the user function calling sequence and modifies program steps for data point processing. It also determines the type of data to be processed, and defines a delta time for the given type. In the second region, TCK determines if the component times in the point array are in

ascending order. A point whose time is out of order is deleted from the tracking data point array in the Constant Pool of the User Function. TCK then checks for missing data points in the third program region and computes a time range, upper and lower limit, for each of the component times in the array. A final range is then formulated and any point whose time is not within the range is also deleted from the tracking data set. An output of the rejected time is written on tape, if requested, by the TCK internal output subroutine.

RESTRICTIONS

A. The maximum number of points processed by TCK is contingent upon the Constant Pool tracking data allocation of the user function. The minimum number of points processed by TCK is two (2). If there is one point or less, TCK exits to the normal return address of the user function.

B. Index registers 1, 5 and 6, pre-TCK entry values, are saved and restored at the completion of TCK operation.

C. The Reference Pool items NT and FORMAT must be set prior to TCK operation. TCK uses NT to process all the data points and resets this item with the number of valid points upon completion. FORMAT (radar data type) is used by TCK to define a delta time (Δ t) for range determination and to ascertain if Doppler (FR and T) data or other type data points (SR, EL, AZ, and T) are to be processed.

D. Since the component times in the tracking data point array must be in machine time, routine TEDIT, or a similar conversion routine, must be executed prior to TCK. TEDIT converts time from fixed point integer seconds to floating point machine time.

E. The components of the tracking data point (T, AZ, EL, SR), must be in parallel structured tables in the Constant Pool of the user function.

F. Two cells of COMMON are used in TCK operation.

G. The following subroutines are used by TCK:

FIX	OUTERR
FLOAT	OUTPUT
SUBERR	

TIMING

TCK program execution time is dependent upon: (1) the number of points processed, (2) the number of times within a given range, (3) the number of times outside a given range, (4) the number of times not in ascending order, and (5) the off-line list option. Approximately 1146.7 milli-seconds are required to process 200 valid tracking data points by TCK.

STORAGE REQUIREMENTS

A. Program Allocation.

Program Steps	135 cells
Storage	12 cells
Constants	8 cells
TOTAL	155 cells

B. Program Storage.

TAG	DESCRIPTION
TCK901	Delta Time (Δt)
TCK902	Current Upper Limit
TCK903	Current Lower Limit
TCK904	Final Upper Limit
TCK905	Final Lower Limit
TCK906	Time Factor
TCK907	Count
TCK908	FORMAT value -1
TCK950	Program loop control to process all points in the data array.
TCKMPTS	Number of missing points
TCKSUM	Summation of mission points in the data array
TCKXRI	Relative position of a given time in the array

C. Program Constants.

TAG	DESCRIPTION	FORMAT	UNITS
TCK951	Output list heading "TIME CHECK"	Binary Coded Decimal	
F1	Constant used in Missing Point Check(1.0)	Floating Point	
F2	Delta Time for Doppler data (2.0)	Floating Point	Seconds
F4	Delta Time for TLM18 or MODII data (4.0)	Floating Point	Seconds
F.5	Time increment (.5)	Floating Point	Seconds
LIMMPTS	Limit for the number of missing point between successive times in the array (15.0)	Floating Point	
MZERO	Program Mask used to complement arithmetic values (7777 7777 7777 7777)	Octal	
D86400	Number of seconds in a 24 hour period (86400)	Fixed Point Integer	Seconds

TRANSFER FUNCTION

A. Terms and Definitions

1. i, j, k, l, m, p = indexers to specify any given point in the tracking data array (relative position). In general, these indexers have a range from 0 to NT-1 or as indicated.
2. NT = Number of tracking data points
3. FORMAT = Type of radar
   0 = Mod II
   1 = Doppler (Range-Rate)
   2 - TLM18
   3 = UHF

4. t = Delta time

   Doppler = 2 seconds

   Mod II, TLM18 = 4 seconds

   UHF = $\frac{\text{Pass Duration}}{\text{NT-1}}$ seconds

5. Tracking Data Point

   T = Time

   EL = Elevation (Range-Rate for Doppler)

   AZ = Azimuth (not used for Doppler)

   SR = Slant Range (not used for Doppler

6. FLL = Final Lower Limit

7. FUL = Final Upper Limit

8. LIMMPTS = Limit for number of missing points (See Program Constants)

9. LISTTFST = Output List Option Indicator

B. Ascending Order Check. Perform until points are in order.

1. If $T_i+1 > T_i$ for all i (i=0, 1, ...NT-2) Points are in order.

2. If $T_i+1 \leq T_i$ for any i A point is out of order

   Find worst point K > j such that: Eliminate point K

$$\left| \sum_{p=0}^{p=NT-1} \alpha pk + K-(NT-1) \right| \geq \left| \sum_{p=0}^{p=NT-1} \alpha pj + j-(NT-1) \right| \quad \text{(See Note)}$$

where: $\alpha_{pk} = 1$ if $T_p > T_k$

$\alpha_{pk} = 0$ if $T_p \leq T_k$

$\alpha_{pj} = 1$ if $T_p > T_j$

$\alpha_{pj} = 0$ if $T_p \leq T_j$

C. Range Determination and Check

1. Compute Range (FLL, FUL)

Find i>ℓ such that $\sum_{j=0}^{j=NT-1} \beta_{ij} \geq \sum_{j=0}^{j=NT-1} \beta_{\ell j}$

where: $\beta_{ij} = 1$ if $T_i - \left[.5+\Delta t(i+Dsum) \right] < T_j \leq T_i + \Delta t(NT-1-i)$

$\beta_{ij} = 0$ otherwise

$\beta_{\ell j} = 1$ if $T_\ell - \left[.5+\Delta t(\ell+Dsum) \right] < T_j \leq T_i + \Delta t(NT-1-i)$

$\beta_{\ell j} = 0$ otherwise

$$Dsum = \sum_{p=0}^{p=NT-2} dp$$

$dp = 0$ if $\frac{Tp+1-Tp}{\Delta t} - 1 >$ LIMPTS

$dp = \frac{Tpi-Tp}{\Delta t} - 1$ otherwise

a. If $\sum_{j=0}^{j=NT-1} \beta_{ij} > \sum_{j=0}^{j=NT-1} \beta_{\ell j}$ Set:

FLL=$T_i - \Delta t(i+Dsum)$

FUL=$T_i + \Delta t(NT-1-i)$

b. If $\sum_{j=0}^{j=NT-1} \beta_{ij} = \sum_{j=0}^{j=NT-1} \beta_{\ell j}$ Set:

FLL=$T_\ell - \Delta t(\ell+Dsum)$

FUL=$T_i + \Delta t(NT-1-i)$

2. Examine all points K

a. If FLL$\leq T_k <$FUL Point is in range.

b. If $T_k <$FLL Point is out of range. Eliminate point K (See Note)

or

$T_k \geq$FUL

Note: To eliminate point K

1. For m = K, K+1, ...NT-2

a. If FORMAT = 1 Set $T_m = T_{m+1}$

$EL_m = EL_{m+1}$

	b. If FORMAT $\neq$ 1	Set: $T_m = T_{m+1}$
		$EL_m = EL_{m+1}$
		$AZ_m = AZ_{m+1}$
		$SR_m = SR_{m+1}$
2.	Reduce number of points	Set: NT = NT-1
3.	If LISTTEST = 0	List Time Eliminated off-line

VALIDATION TESTS

A test routine was written to provide input parameters to TCK and to output program results utilizing the COP Defines function. Ten tests were run consisting of a set of ten tracking data points for each type of data. In addition, several tests of 200 points were made to validate the missing point computations in TCK. After analysis of the test results, given data points were deleted from the tracking data array when a component time was out of order or out of the computed range. In a like manner, no points were rejected when the time interval between successive points was other than nominal and when the number of missing points was not greater than the program limit of 15 points. The program option to list "bad" times was exercised and operated correctly. The number of points (NT in the Reference Pool) was also updated correctly for each point rejected by TCK.

REFERENCE

A. LMSD-447578, 1604 Systems Manual

PROGRAM	PAGE
OUTPUT	45.01.01
COMPARE	45.10.01
OUTERR	50.05.01
SUBERR	50.06.01
CCOORD	55.05.21
REDUCE	55.25.29

PROGRAM	PAGE
TCK	55.35.11
TEDIT	55.50.25
DATLAP	55.60.01

B. Manual of Operating Instructions for Satellite Control Computer Programs.

PROGRAM	PAGE
ASCENT	3.2.1
NBURN	3.4.1
REENTRY	3.6.1

C. TM-(L)-715/008/00, General Purpose Satellite Control Program Description of FIX.

D. TM-(L)-715/009/00, General Purpose Satellite Control Program Description of FLOAT.

FLOW CHART

Terms and Definitions:

i, j, k = An integer to specify any given element in the tracking data array (relative position). This value has a range of 0 through NT-1 and is set as indicated.

NT = Number of tracking data points

Δt = Delta Time

Doppler = 2 seconds

MODII, TLM18 = 4 seconds

$$UHF = \frac{\text{Pass Duration}}{NT-1} \text{ seconds}$$

Tracking Data Point

T = Time

EL = Elevation

AZ = Azimuth

SR = Slant Range

Doppler (Range-Rate)

MODII
TLM 18
UHF

D = The number of missing points between two successive times.

D_{SUM} = The summation of missing points in the tracking data set.

TF = Time Factor

CLL = = Current Lower Limit

CUL = Current Upper Limit

$COUNT_p$ = Previous Cound

$COUNT_e$ = Current Count

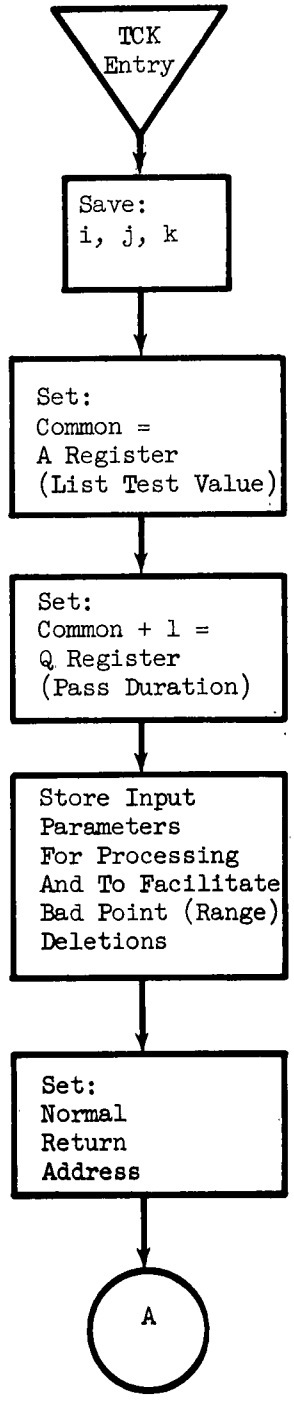
(T>CLL) = An integer denoting the number of Times in the array which are greater than the current lower limit.

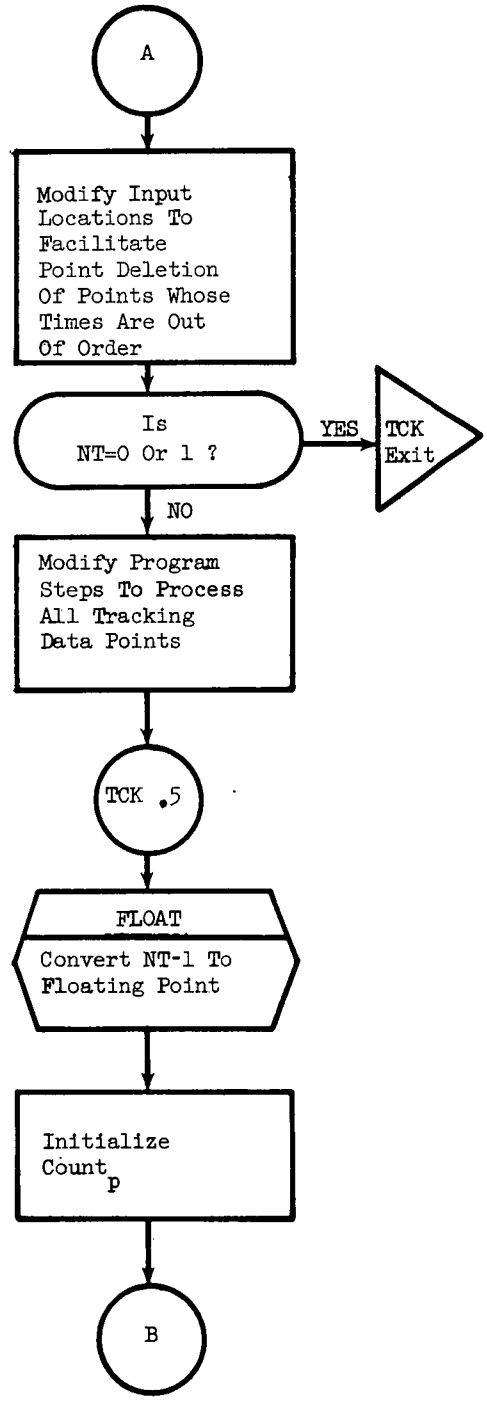
(T>CUL) = An integer denoting the number of times in the array which are greater than the current upper limit.

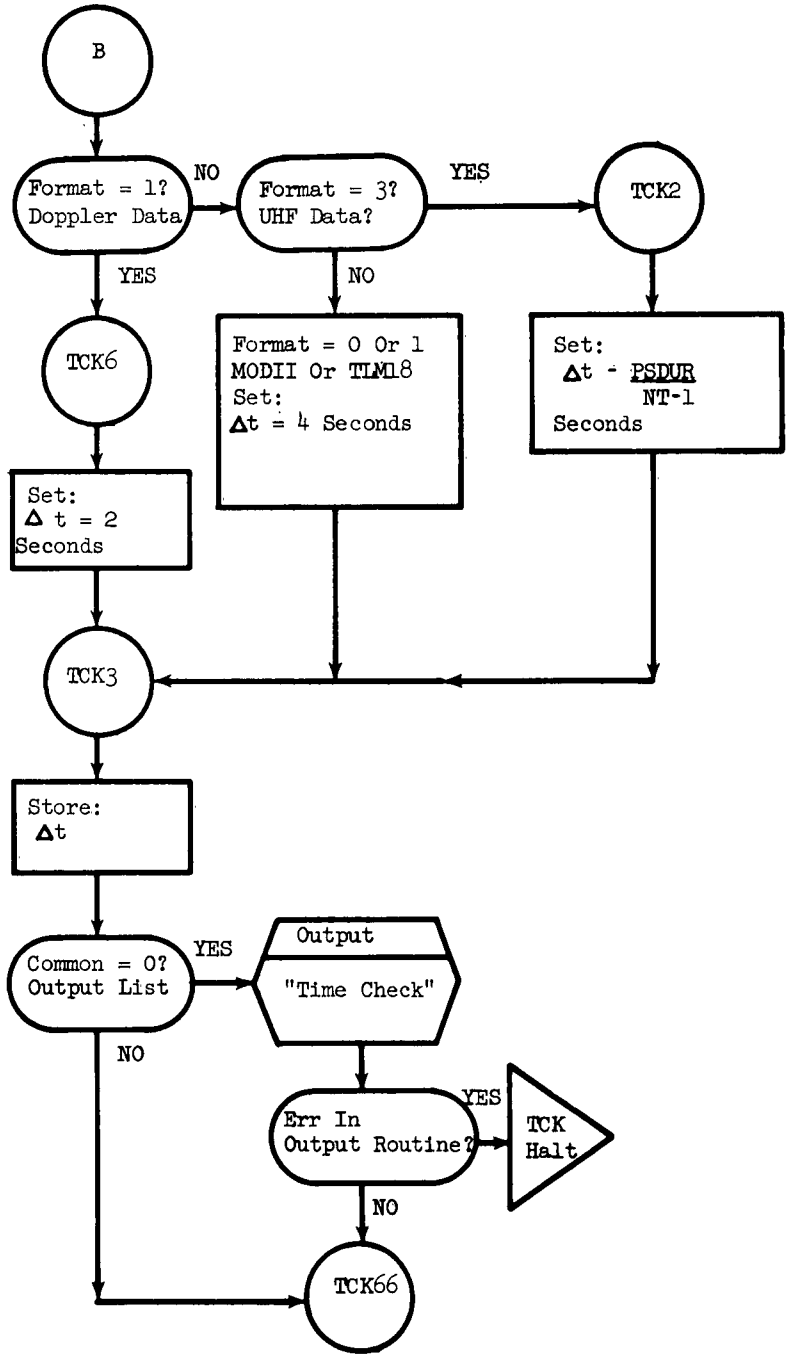
$NTGT_i$ = An integer denoting the number of Times in the tracking data set which are greater than a given time in the set(T_i).

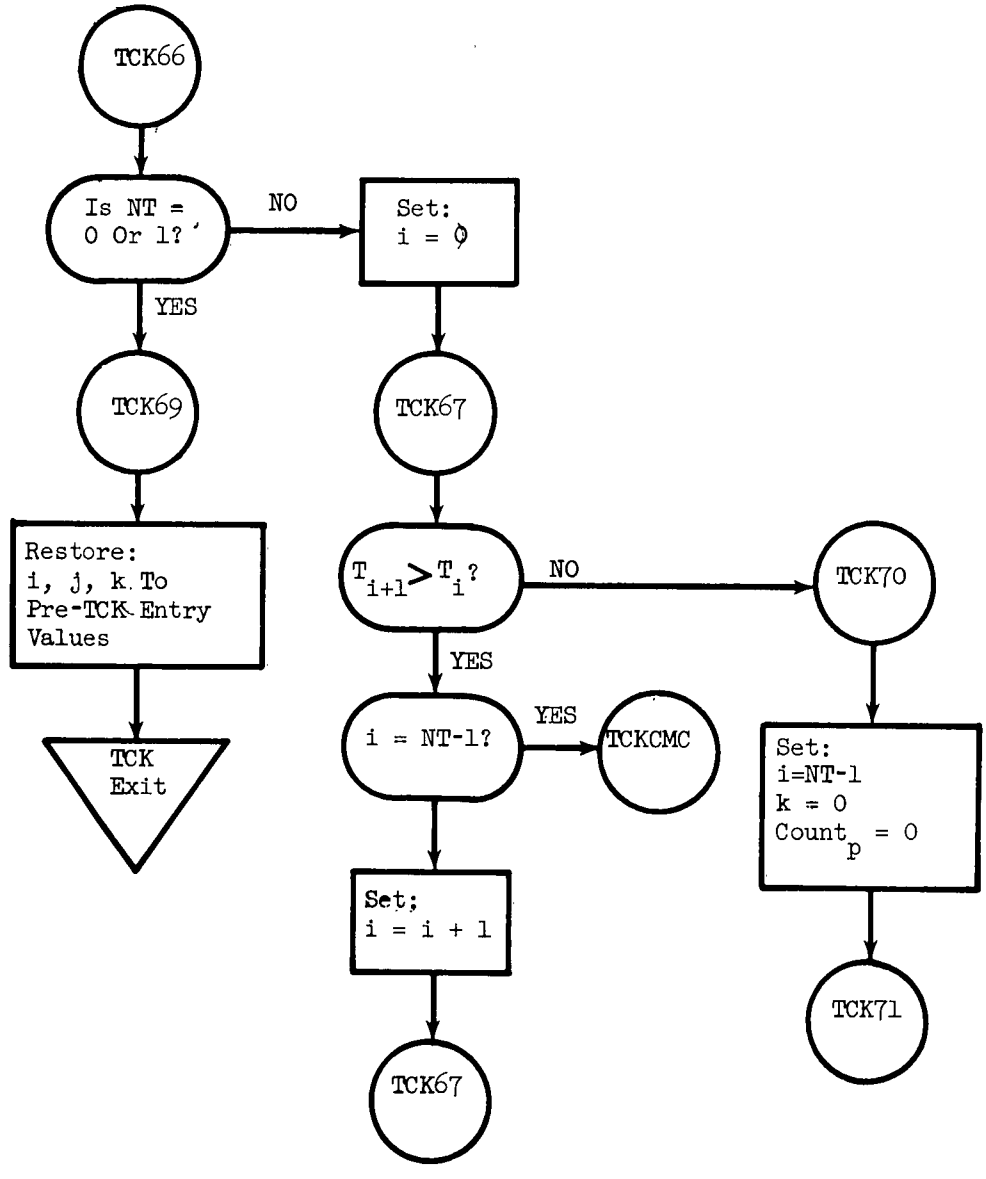
FLL = Final Lower Limit

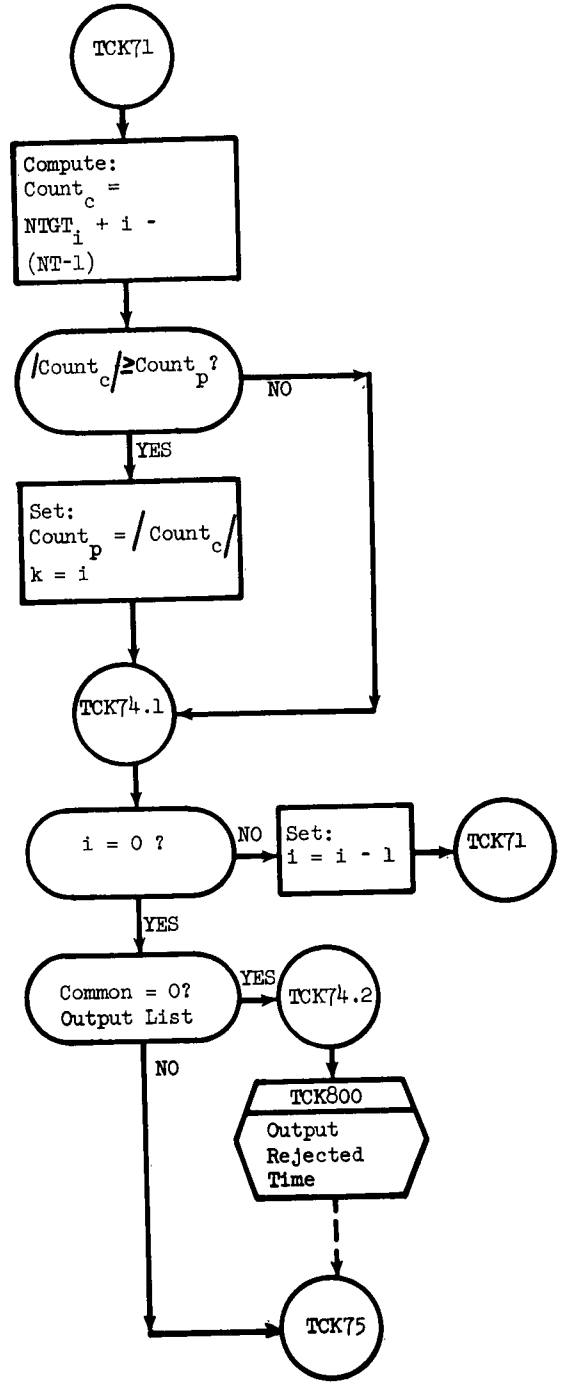
FUL = Final Upper Limit

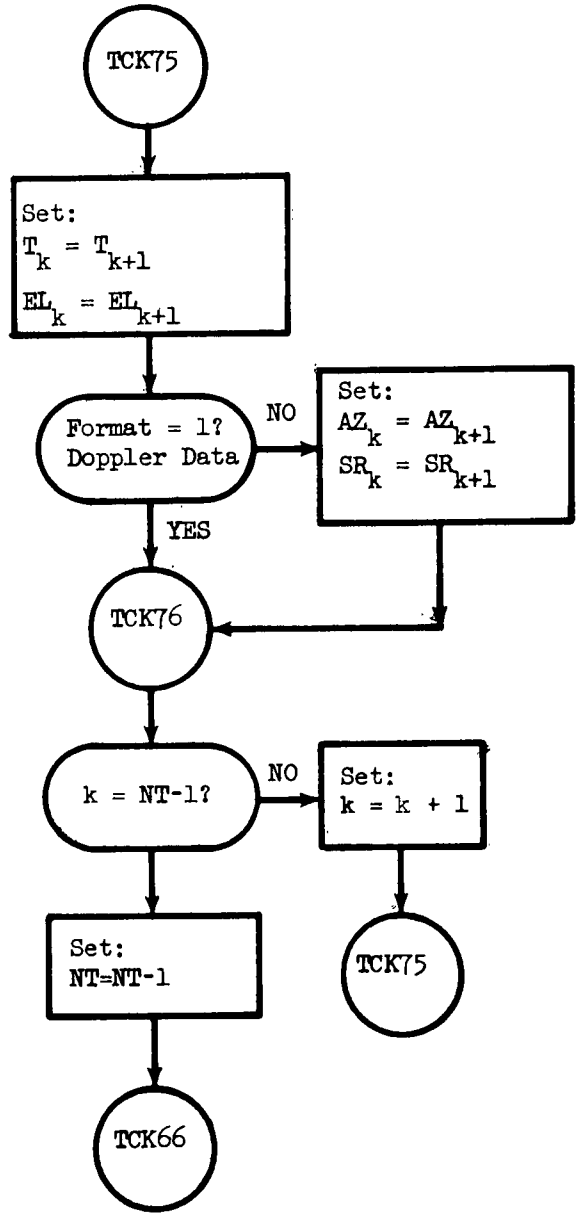

TCK
Entry
Save:
i, j, k
Set:
Common =
A Register
(List Test Value)
Set:
Common + 1 =
Q Register
(Pass Duration)
Store Input
Parameters
For Processing
And To Facilitate
Bad Point (Range)
Deletions
Set:
Normal
Return
Address
A

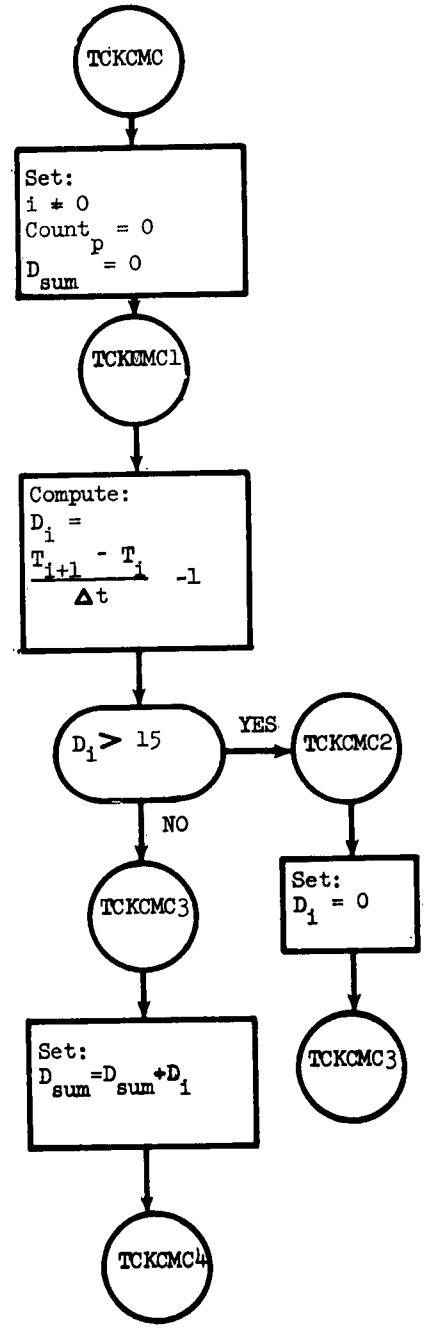

A
Modify Input Locations To Facilitate Point Deletion Of Points Whose Times Are Out Of Order
Is NT=0 Or 1 ?
YES
TCK Exit
NO
Modify Program Steps To Process All Tracking Data Points
TCK .5
FLOAT
Convert NT-1 To Floating Point
Initialize Count p
B

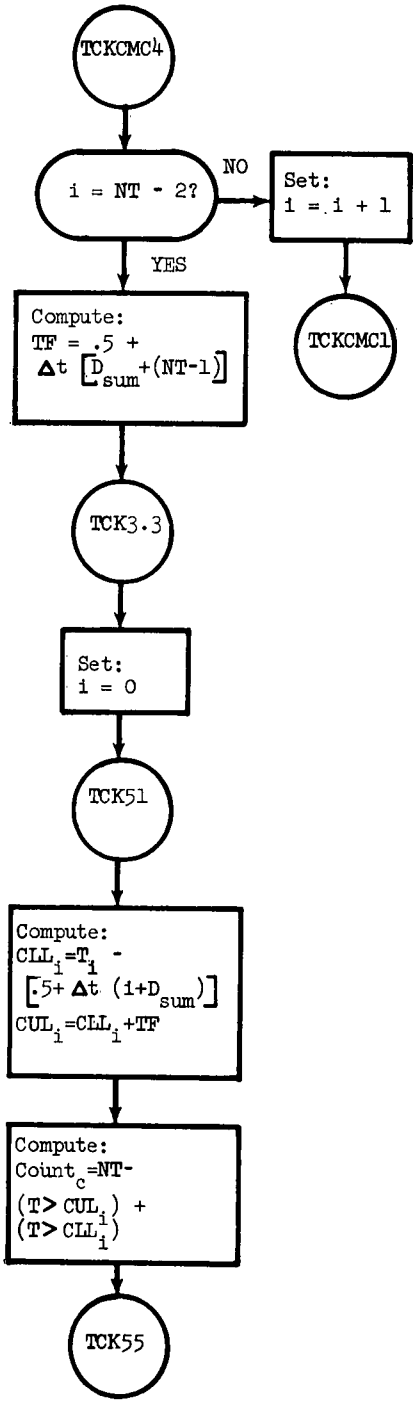

B
Format = 1? Doppler Data
NO
Format = 3? UHF Data?
YES
TCK2
YES
NO
TCK6
Format = 0 Or 1 MODII Or TLM18 Set: Δt = 4 Seconds
Set: Δt - PSDUR NT-1 Seconds
Set: Δ t = 2 Seconds
TCK3
Store: Δt
Common = 0? Output List
YES
Output "Time Check"
NO
Err In Output Routine?
YES
TCK Halt
NO
TCK66

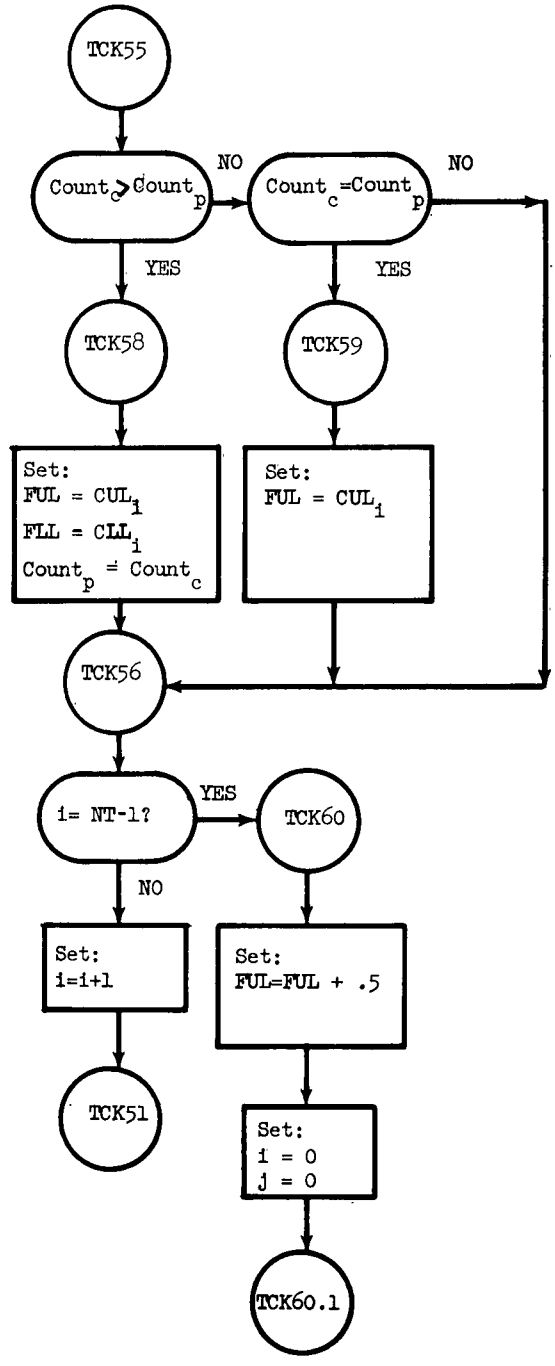

TCK66
Is NT = 0 Or 1?
NO
Set: i = 0
YES
TCK69
TCK67
Restore: i, j, k To Pre-TCK Entry Values
$T_{i+1} > T_i$?
NO
TCK70
YES
TCK Exit
i = NT-1?
YES
TCKCMC
Set: i=NT-1 k = 0 $Count_p$ = 0
Set; i = i + 1
TCK71
TCK67

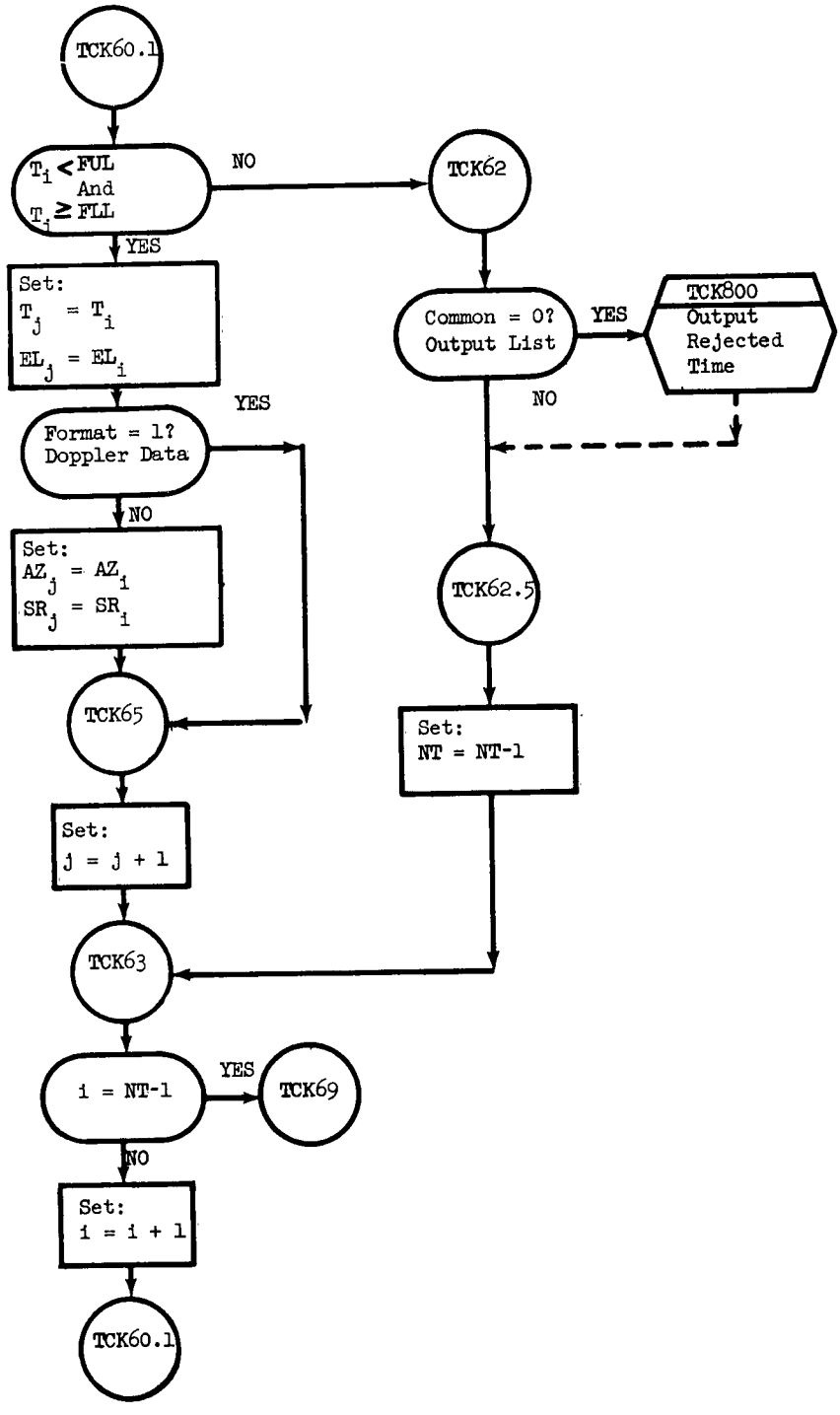

TCK71
Compute:
Count_c =
NTGT_i + i -
(NT-1)
/Count_c/ ≥ Count_p ?
NO
YES
Set:
Count_p = /Count_c/
k = i
TCK74.1
i = 0 ?
NO
Set:
i = i - 1
TCK71
YES
Common = 0?
Output List
YES
TCK74.2
NO
TCK800
Output
Rejected
Time
TCK75

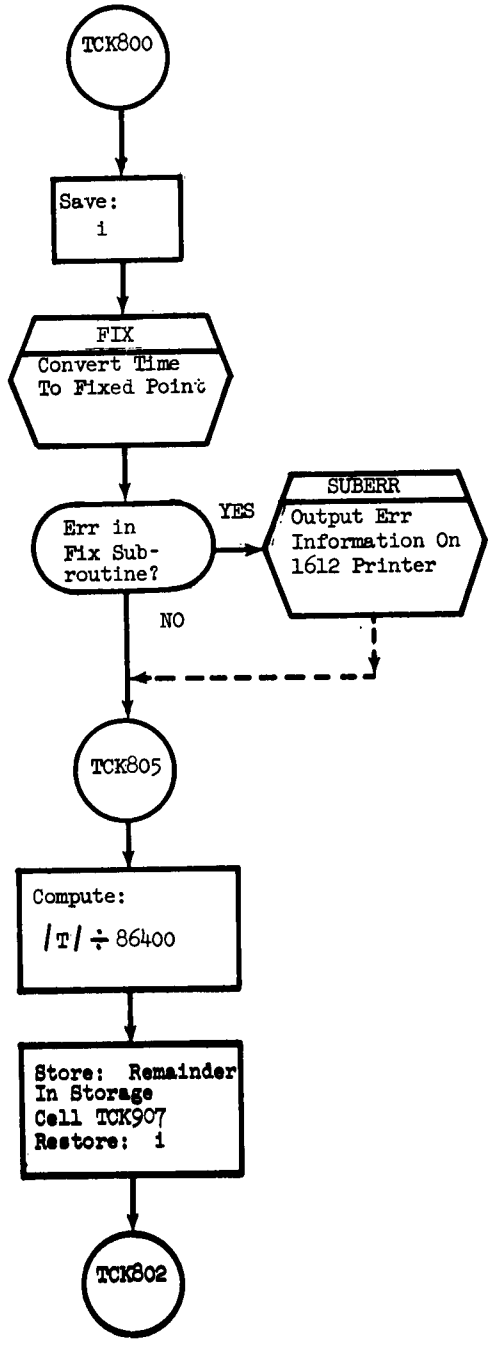

TCK75
Set:
$T_k = T_{k+1}$
$EL_k = EL_{k+1}$
Format = 1?
Doppler Data
NO
Set:
$AZ_k = AZ_{k+1}$
$SR_k = SR_{k+1}$
YES
TCK76
k = NT-1?
NO
Set:
k = k + 1
Set:
NT=NT-1
TCK75
TCK66

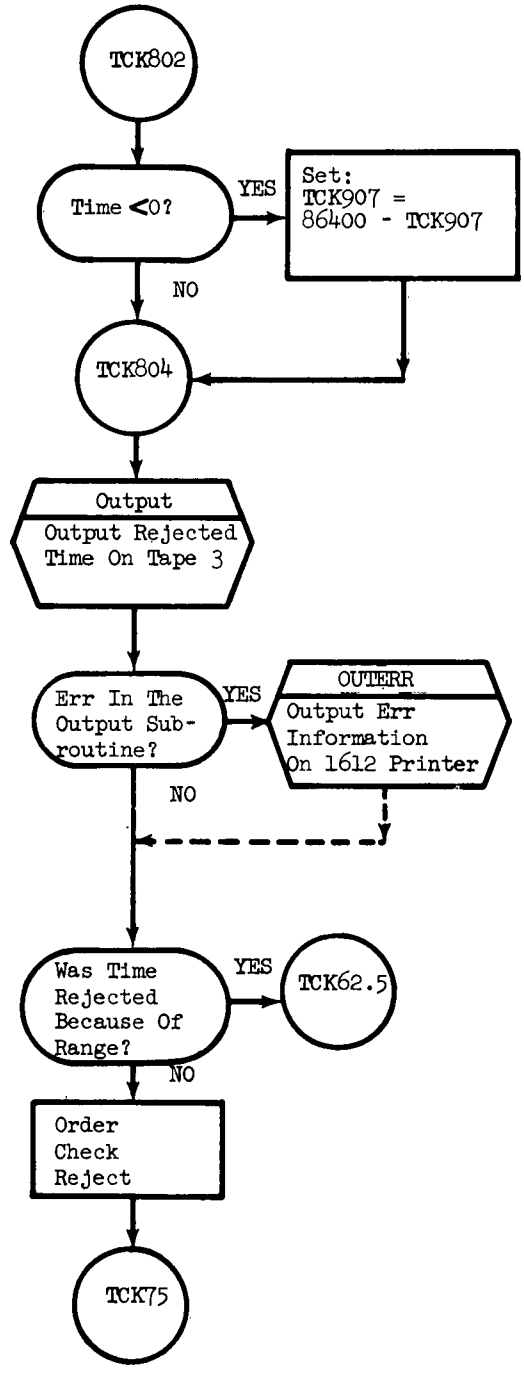

TCKCMC
Set:
i = 0
Count_p = 0
D_sum = 0
TCKCMC1
Compute:
D_i = (T_i+1 - T_i)/Δt - 1
D_i > 15
YES
TCKCMC2
NO
TCKCMC3
Set:
D_i = 0
TCKCMC3
Set:
D_sum = D_sum + D_i
TCKCMC4


TCKCMC4
i = NT - 2?
NO
Set:
i = i + 1
YES
TCKCMC1
Compute:
TF = .5 +
Δt [D sum +(NT-1)]
TCK3.3
Set:
i = 0
TCK51
Compute:
CLL i =T i -
[.5+ Δt (i+D sum)]
CUL i =CLL i +TF
Compute:
Count c =NT-
(T> CUL i) +
(T> CLL i)
TCK55


TCK55
Count_c > Count_p
NO
Count_c = Count_p
NO
YES
YES
TCK58
TCK59
Set:
FUL = CUL_i
FLL = CLL_i
Count_p = Count_c
Set:
FUL = CUL_i
TCK56
i= NT-1?
YES
TCK60
NO
Set:
i=i+1
Set:
FUL=FUL + .5
TCK51
Set:
i = 0
j = 0
TCK60.1


TCK60.1
$T_i < FUL$ And $T_i \geq FLL$
NO
TCK62
YES
Set: $T_j = T_i$ $EL_j = EL_i$
Common = 0? Output List
YES
TCK800 Output Rejected Time
NO
YES
Format = 1? Doppler Data
NO
Set: $AZ_j = AZ_i$ $SR_j = SR_i$
TCK62.5
TCK65
Set: NT = NT-1
Set: j = j + 1
TCK63
i = NT-1
YES
TCK69
NO
Set: i = i + 1
TCK60.1


TCK800
Save:
i
FIX
Convert Time
To Fixed Point
Err in
Fix Sub-
routine?
YES
SUBERR
Output Err
Information On
1612 Printer
NO
TCK805
Compute:
/T/ ÷ 86400
Store: Remainder
In Storage
Cell TCK907
Restore: i
TCK802


TCK802
Time <0?
YES
Set:
TCK907 =
86400 - TCK907
NO
TCK804
Output
Output Rejected
Time On Tape 3
Err In The
Output Sub-
routine?
YES
OUTERR
Output Err
Information
On 1612 Printer
NO
Was Time
Rejected
Because Of
Range?
YES
TCK62.5
NO
Order
Check
Reject
TCK75

External Distribution List

Space Systems Division
(Contracting Agency)
Major. C. R. Bond (SSOCD)

6594th Aerospace Test Wing
(Contracting Agency)
Col. A. W. Dill (TWRD)
Lt. Col. M. S. McDowell (TWRU) (4)
TWACS (6)

PIR-E1 (Lockheed)
N. N. Epstein
C. H. Finnie
H. F. Grover
W. E. Moorman (5)
461 Program Office
698BK Program Office

PIR-E2 (Philco)
J. A. Bean
J. A. Isaacs
R. Morrison (5)
S. M. Stanley

PIR-E3 (LFE)
D. F. Criley
K. B. Williams

PIR-E8 (Mellonics)
F. Druding

PIR-E5 (Aerospace)
F. M. Adair
R. O. Brandsberg
L. H. Garcia
G. J. Hansen
C. S. Hoff
L. J. Kreisberg
T. R. Parkin
E. E. Retzlaff
H. M. Reynolds
D. Saadeh
R. G. Stephenson
V. White

PIR-E7 (STL)
A. J. Carlson
R. L. Mills

PIR-E4 (GE - Sunnyvale)
D. Alexander
J. Farrentine
N. Kirby

PIR-E4 (GE - Box 8555)
J. S. Brainard
H. G. Klose
J. D. Selby

PIR-E4 (GE - 3198 Chestnut)
J. F. Butler
H. D. Gilman

PIR-E4 (GE - Bethesda)
W. L. Massey

PIR-E4 (GE - Box 8661)
J. D. Rogers

Distribution List

AFCPL	(5)	KEDDY, J. R.	24105
ALLFREE, D.	24083	KEY, C. D.	23013
ALPERIN, N. I.	22153	KEYES, R. A.	24073
ARMSTRONG, E.	24123	KINKEAD, R. L.	22093
BERNARDS, R. M.	SUNNYVALE	KNEEMEYER, J. A.	22088A
BIGGAR, D.	24118A	KNIGHT, R. D.	22119
BILEK, R. W.	23007	KOLBO, L. A.	22155
BLACK, H.	14039	KOSTINER, M.	14056B
BRENTON, L. R.	24103B	KRALIAN, R. P.	14039
BURKE, B. E.	24086	KRISTENSEN, K.	SUNNYVALE
BURKE, R. F.	22158	LACHAPELLE, F.	22093
CHAMPAIGN, M. E.	22152	LAUGHLIN, J. L.	24073
CHIODINI, C. M.	24091	LAVINE, J.	24093
CIACCIA, B. G.	24082A	LITTLE, J. L.	24088B
CLINE, B. J.	24127	LONG, F.	22156
COGLEY, J. L.	22156	MADRID, G. A.	22081
CONGER, L.	24088A	MAHON, G. A.	24089
COOLEY, P. R.	24081	MARIONI, J. D.	24076B
COURT, T. D.	24086B	MARTIN, W. P.	24127B
CRUM, D. W.	24105	MCKEOWN, J.	23013
DANT, G. B.	24086B	MICHAELSON, S. A.	14039
DECUIR, L. E.	24053A	MILANESE, J. J.	22155
DERANGO, W. C.	24082B	MUNSON, J. B.	22087A
DEXTER, G. W.	25016	MYERS, G. L.	14056A
DISSE, R. J.	23014	NELSON, P. A.	24075
DOBBS, G. H.	22116B	NG, J.	22077
DOBRUSKY, W. B.	24065A	NGOU, L.	24127
ELLIS, R. C.	22131A	PADGETT, L. A.	24110A
EMIGH, G. A.	14039	PATIN, O. E.	SUNNYVALE
ERICKSEN, S. R.	22113	POLK, T. W.	24113
FELKINS, J.	24097	PRUETT, B. R.	22084
FOSTER, G. A.	14039	RAYBIN, M.	14039
FRANKS, M. A.	24122	REILLY, D. F.	24121
FREY, C. R.	22078	REMSTAD, C. L.	25026
FRIEDEN, H. J.	22082	RUSSELL, R. S.	14054
GARDNER, S. A.	25026	SCHOLZ, J. W.	14039
GREENWALD, I. D.	22094A	SCOTT, R. J.	24110
GRIFFITH, E. L.	22081	SEACAT, C. M.	SUNNYVALE
HAAKE, J. W.	22153	SEIDEN, H. R.	22126B
HARRIS, E. D.	24081	SHAPIRO, R. S.	24110B
HENLEY, D. E.	22094B	SKELTON, R. H.	22148
HILL, C. L.	22101	SOLOMON, J.	22076
HILLHOUSE, J.	22078	SPEER, N. J.	24086A
HOLMES, M. A.	24103	STONE, E. S.	24058B
HOLZMAN, H. J.	24065B	SWEENEY, M. J.	25026
HOUGHTON, W. H.	24103B	TABER, W. E.	22101
HOYT, R. L.	14039	TENNANT, T. C.	27029
IMEL, L. E.	14039	TESTERMAN, W. D.	14039
KASTAMA, P. T.	22076	THOMPSON, J. W.	24088
KAYSER, F. M.	24109	THORNTON, R. L.	14050

Distribution List (cont.)

TOTSCHEK, R. A.	24120	WINSOR, M. E.	22156
VORHAUS, A. H.	24076A	WINTER, J. E.	24117
WAGNER, I. T.	24093	WISE, R. C.	22085
WARSHAWSKY, S. B.	24097	WONG, J. P.	SUNNYVALE
WEST, G. D.	SUNNYVALE	ZACHTE, S. A.	24086
WEST, G. P.	22116A	ZUBRIS, C. J.	24075
WILSON, G. D.	24124		

UNCLASSIFIED

System Development Corporation,
Santa Monica, California
GENERAL PURPOSE SATELLITE COMPUTER
PROGRAM DESCRIPTIONS MILESTONE 11
TIME CHECK (TCK).
Scientific rept., TM(L)-714/012/00,
by C. M. Chiodini. 14 November 1962,
22p.
(Contract AF 19(628)-1648, Space Systems
Division Program, for Space Systems
Division, AFSC)

Unclassified report

DESCRIPTORS: Satellite Networks.
Programming (Computers).

UNCLASSIFIED

UNCLASSIFIED

Reports that TCK (Time Check)
deletes Tracking Data Points from
the Constant Pool of the user
function when the component times (T)
are out of range or out of order.

UNCLASSIFIED